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REPORT ON THE WEATHER BUREAU RADIOMETEOROGRAPH PROGRAM

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Remarkable progress has been made in this country during the past 2 years in the development of radiometeorographs; at least 5 different types have been developed. In January 1937, when it was necessary for the Weather Bureau to decide on its program for the fiscal year beginning July 1, 1937, no one type had been sufficiently developed for regular use in scheduled observations. It was, therefore, deemed best to continue the study of all 5 types in order to explore more thoroughly the best features of each.

At the Central Office of the Weather Bureau in Washington, all of the various types of radiometeorographs are being used in an attempt to develop the most suitable calibration and receiving apparatus, evaluation methods, launching technique, etc. A specialist in radiometeorography has recently been added to the Central Office staff for this purpose.

The designers of the 5 types are: (1) H. Diamond and W. S. Hinman, Jr., and their collaborators of the National Bureau of Standards in cooperation with the Navy Department and Julien P. Friez and Sons, Inc.; (2) L. F. Curtiss and A. V. Astin of the National Bureau of Standards in cooperation with the Weather Bureau; (3) O. C. Maier and L. E. Wood of the California Institute of Technology; (4) K. O. Lange, A. E. Bent, and C. B. Pear, Jr., of Blue Hill Observatory, Harvard University; and (5) the Weather Bureau in cooperation with Julien P. Friez and Sons, Inc., Baltimore, Md.

Development was continued by Diamond and his collaborators on their instrument; and the Weather Bureau, again this fiscal year, transferred a sum of money to the National Bureau of Standards for continuing the development of the Curtiss and Astin type. With regard to the other three types of radiometeorographs, the Weather Bureau set up a program having a twofold objective: to maintain close contact between the manufacturer and the Weather Bureau personnel making the observations; and to operate a station far distant from the manufacturer.

In accordance with the program, daily radiometeorograph observations were begun at the Weather Bureau Airport Station, Burbank, Calif., September 1, 1937, and are to continue until June 30, 1938. The instruments used there are known as the Galcit type, developed at the California Institute of Technology. These meteorographs are calibrated by the contractor in Pasadena and are delivered to the Burbank station in small lots so that an instrument is available each day. The soundings are made, as nearly as practicable, at the same time as the airplane observations at San Diego Naval Air Station so that comparisons of the data can be made.

At the Boston Weather Bureau Airport Station, daily radiometeorograph observations were begun October 1, 1937, and are to continue until June 30, 1938. The Harvard type instrument developed at Blue Hill Observatory, is being used there. While close contact between the Bureau personnel and the contractor in Cambridge, Mass., is also possible at Boston, the arrangements there require the instruments to be calibrated by the Weather Bureau instead of by the contractor. This procedure was adopted in order to determine which plan might prove best for future policy. Prior to the discontinuance of the Army airplane observations at Boston on December 31, 1937, the radio soundings were made at the same time for comparison.

In connection with an investigation of the structure of polar continental air and the development of cold waves in North America, authorized under the Bankhead-Jones Act, the Weather Bureau made daily radiometeorograph observations at Fairbanks, Alaska, from October 7, 1937, to March 15, 1938. The instruments used there are known as the Weather Bureau type and are manufactured in Baltimore. They were shipped in monthly lots to Fairbanks, where they were calibrated by Bureau personnel. Under this plan, the practicability of transporting the instruments long distances and of using them under severe weather conditions was studied. Airplane observations were made at Fairbanks every third day during this period for comparison with the radiometeorograph data.

The observations are promptly evaluated and data for the meteorologically significant levels transmitted by radio to Washington, and to other stations, where they are charted and analyzed in conjunction with the regular aerological reports.

During the first 122-day period at Burbank, 97 radio meteorograph records were obtained; of these, 87 percent exceeded 5 km, 42 exceeded 10 km, and 13 exceeded 15 km. The maximum height attained at Burbank was 19.5 km.

During the first 92-day period at Boston, 77 radiometeorograph records were obtained; of these 87 percent exceeded 5 km, 25 exceeded 10 km, and 4 exceeded 15 km. The maximum height attained at Boston, was 22.2 km.

During the first 86-day period at Fairbanks, 60 radiometeorograph records were obtained; of these, 75 percent exceeded 5 km, 13 exceeded 10 km, and none reached 15 km. The maximum height attained at Fairbanks was 12.9 km.

In table 1 are shown the percentages obtained for differences of the temperatures indicated by the radiometeorographs from those shown by the airplane observations at the significant levels for the period of observation ending December 31, 1937. Because of the distance between Burbank and San Diego, the data below 1 km at these 2 stations were not included in this comparison. The figures in the upper left corners of the first columns for each station indicate the total number of cases on which the percentages are based.

TABLE 1

	Burbank			Boston			Fairbanks		
	0°–1°	1°–2°	>2°	0°–1°	1°–2°	>2°	0°–1°	1°–2°	>2°
September	65 35	25	40						
October	116 35	22	43	178 21	25	54	46 37	11	52
November	107 31	22	47	173 45	26	29	39 39	10	51
December	139 27	30	43	128 37	28	35	58 26	24	50
Total	427 32	25	43	479 34	27	39	143 34	15	51

In table 2 are shown the percentages obtained for a comparison of relative humidities using the same method as for temperature. Humidity comparisons were made for temperatures above 0° C. only as well as for all temperatures.

TABLE 2

BURBANK

	0–5%	5–10%	10–15%	15–20%	20–25%	>25%
September:						
Above 0° C	58 31	33	24	7	5	0
All temperatures	68 31	34	24	7	4	0
October:						
Above 0° C	83 35	22	18	16	9	6
All temperatures	113 34	19	11	19	10	7
November:						
Above 0° C	72 28	28	22	12	3	7
All temperatures	106 28	24	23	12	5	8
December:						
Above 0° C	81 28	26	17	9	9	11
All temperatures	141 26	26	16	11	8	13
Total:						
Above 0° C	294 31	27	19	11	6	6
All temperatures	428 30	26	18	12	7	7

BOSTON

October:						
Above 0° C	63 41	29	8	11	3	8
All temperatures	147 34	23	17	15	3	8
November:						
Above 0° C	41 39	24	10	7	5	15
All temperatures	137 34	22	16	6	9	13
December:						
Above 0° C	4 75	0	25	0	0	0
All temperatures	120 29	14	18	9	8	22
Total:						
Above 0° C	108 52	18	14	6	3	7
All temperatures	404 32	20	17	10	7	14

FAIRBANKS

October:						
Above 0° C	15 20	20	20	20	7	13
All temperatures	34 18	23	20	18	9	12
November:						
Above 0° C	0					
All temperatures	36 50	14	19	6	3	8
December:						
Above 0° C	1 0	0	0	0	100	0
All temperatures	39 38	28	10	13	3	8
Total:						
Above 0° C	16 10	10	10	10	53	7
All temperatures	109 35	22	16	13	5	9

In figures 1, 2, and 3 are shown the temperature-altitude graphs for the last periods in December for which both airplane and radiometeorograph data were available for the three stations. The times (75th meridian) of launching are a. m. except where p. m. is indicated; the surface temperature is indicated and each abscissa interval corresponds to 10° C. The numbers adjacent to the curves are relative humidities.

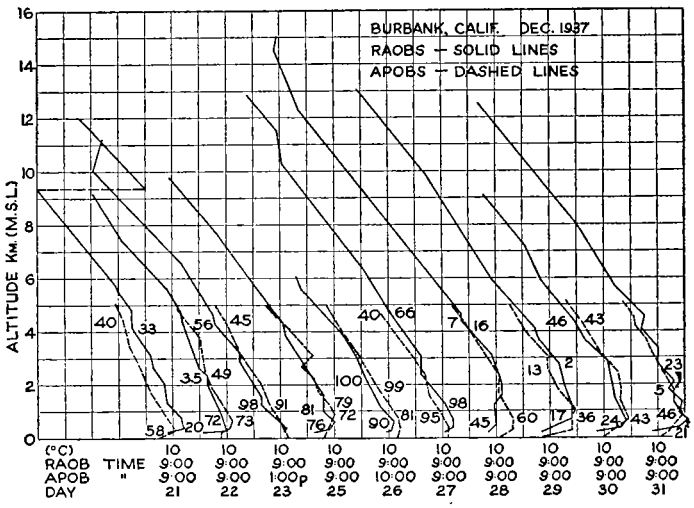

FIGURE 1.

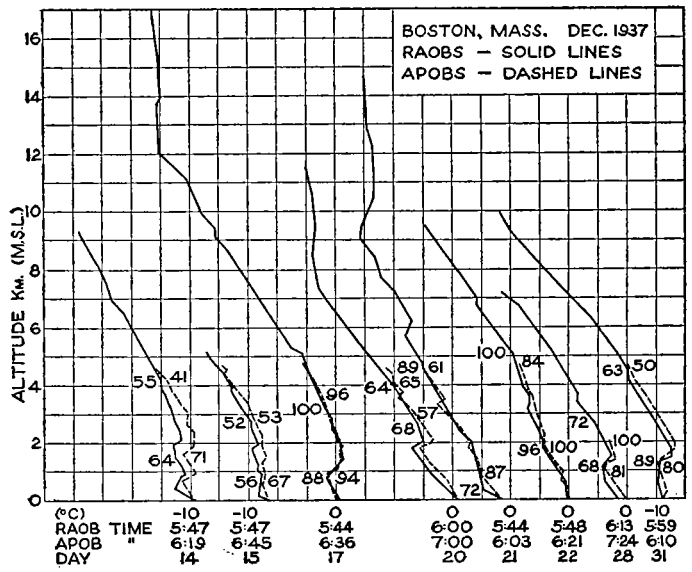

FIGURE 2.

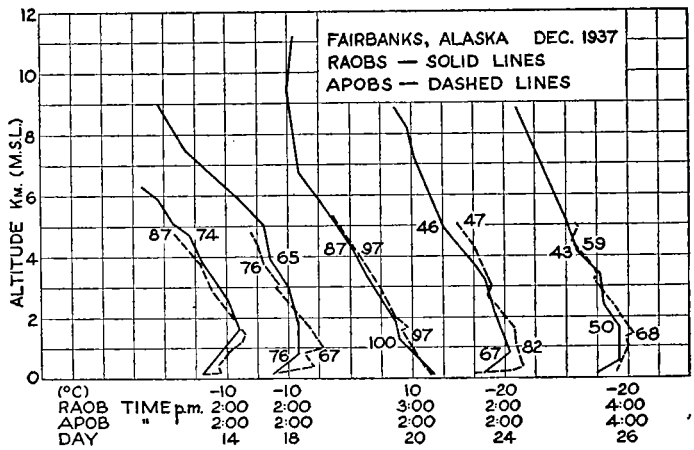

FIGURE 3.

Before conclusions can be drawn from these results, however, a number of factors must be taken into account.

These include: differences in the paths followed by the airplane and the balloon and therefore possibly even different air masses encountered; the limited experience of personnel in the technique of calibrating and of making regularly scheduled observations of this kind; differences in time, in some cases, between the airplane and radiometeorograph observations; differences in rate of ascent and lag of radiometeorograph and aerometeorograph; possible changes in the aerometeorograph since last calibration; and possible differences between the initial temperatures of the instruments.

It is planned in the near future to obtain comparisons by sending aloft the various types of radiometeorographs simultaneously from the same place, with recording, i. e., nonradio, meteorographs attached to the same balloon. This method of comparison is considered to be more reliable than the airplane observations used so far.

In view of the promising results being obtained with radiometeorographs and because of the great value of the observational data, it is planned to increase the number of stations to six next fiscal year. To do this, it will be necessary to replace airplane with radiometeorograph observations at some places, since additional funds were not made available for this work. An important factor in this connection, which should reduce the cost materially at favorably located stations, is the large percentage of instruments which will be found and returned. The percentages of recovery for some of the past sounding balloon series made in this country with recording meteorographs, i. e., the nonradio types, are given in table 3.

TABLE 3

Place	Number of observations	Percentage returned
Omaha, Nebr.	306	92
St. Louis, Mo.	115	94
Royal Center, Ind.	80	91
Dallas, Tex.	77	83
Ellendale, N. Dak.	64	91
Groesbeck, Tex.	44	84
Broken Arrow, Okla.	34	76
Huron, S. Dak.	26	92
Avalon, Calif.	23	65

With the experience which will be gained during the next fiscal year, it seems probable that most of the airplane observations will be replaced by radiometeorographs after June 1939.

It is desired to acknowledge the assistance of M. E. Crawford of the Aerological Division for drawing the graphs shown.

RECORD-BREAKING ANNUAL PRECIPITATION, 1846–1850

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Available records for the years of 1846 to 1850 establish the fact that over limited areas of northeastern United States remarkably heavy annual precipitation must have occurred. For instance, southwestern Ohio experienced wetness that has never been approached since that time; a peak of 62.96 inches was recorded at Dayton during 1846 and 65.18 inches at Cincinnati during 1847. Correspondingly heavy precipitation apparently fell at points as far west as St. Louis, where 65.36 inches were recorded during 1848. A curious feature is the time lag of a year between the maximum amounts at each of the three stations. The similarity of these maximum figures tend to bear out the authenticity of the data, although gages or methods of measurements might have differed materially in those days. At Steubenville, Ohio, it is also to be noted that there was a surplus for which we find no equal in later records of southeastern Ohio.

Judging by graphs of all the above stations, not only did copious rains occur but the yearly variation was more erratic than it has ever been since. This condition lasted until about 1860; at least one bad drought is evident between 1850 and 1860. It is interesting to note that extreme positive departures for precipitation at the above stations were never offset by negative departures of equal or greater magnitude. One cannot reach any definite conclusions from the foregoing data because of the paucity of records prior to that time and the fact that nearby stations disagree in some of the main characteristics.

At Dayton the old record was kept at Cooper's Seminary, which is remembered as having had a good standard for educational work. Originally this old part of the record was omitted from precipitation charts as seemingly doubtful, but more recent studies indicate that it should be included. It is presented in the accompanying graph with missing years adapted from the Woodward High School record at Cincinnati. This is on the assumption that it gives a general idea of the trend for the missing years; the normal annual difference between Dayton and Cincinnati is only 0.69 inch.

The extremely wet years were preceded and followed by subnormal rains in 1845 and in 1851; thus, rain diagrams show a sharply defined positive area for the intervening years. At St. Louis precipitation decreased considerably after 1848 but increased again to the all time maximum of 68.83 inches in 1858. In eastern Ohio, and as far east as Pittsburgh, the years 1846 to 1850 reveal similar characteristics for precipitation except that the amounts are not nearly as excessive as in southwestern Ohio. Annual fluctuations were more marked subsequent to the early years mentioned and down to the year 1890. To the south, Springdale, Kentucky, showed an average excess for the period 1846 to 1850 of 5.33 inches. Much farther south, at New Orleans, rain was below normal within the wet interval, while as far east as Rochester, N. Y., it was just slightly in excess.

The above figures would serve to uphold the tradition that "it doesn't rain like it used to," at least for a few sections in the Northeastern States. For southwestern Ohio it looks as if back in the years 1846 to 1850 rain making forces within the atmosphere reached their maximum of recorded history. Annual amounts of 56 inches or more appear in the records as late as the year 1890, but after that they are exceeding rare. The accompanying graphs of precipitation at Dayton, Cincinnati, and St. Louis were taken from the *Climatic Summary of the United States*, 1930 edition.